**Unit Test: Molecular Genetics**

by: Hina T, Zarah A, Jacqueline C

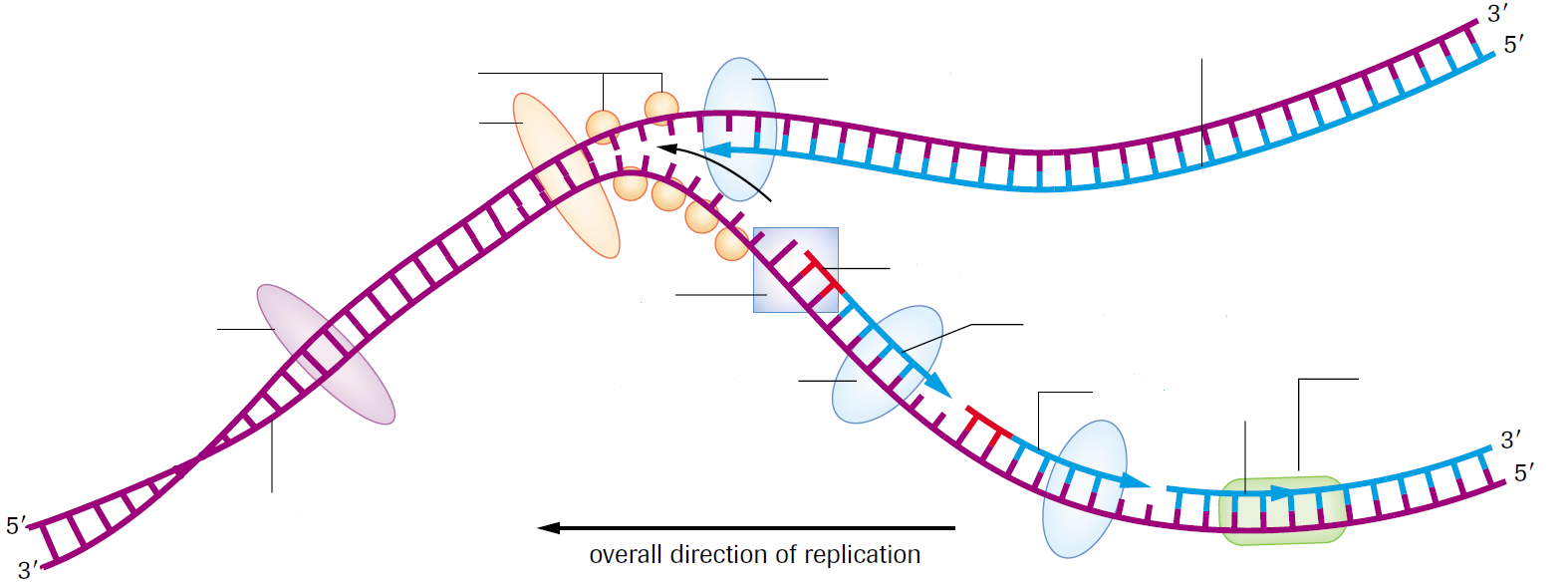
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Knowledge | Application | Thinking/Inquiry | Communication | TOTAL |
| /20 | /13 | /13 | /20 | /66 |

**Part A:** Knowledge/Understanding [20]

*Choose* ***one*** *correct option from each of the following questions.*

1. A deoxyribonucleoside triphosphate is made up of the following parts:
2. N – base
3. N – base, sugar
4. N – base, sugar and a phosphate
5. N – base, sugar and two phosphates
6. N – base, sugar and three phosphates
7. What is the name of the bond that connects the ribose to the N – base:
8. ester linkage
9. glycosidic bond
10. glycosyl bond
11. peptide bond
12. phosphodiester bond
13. What is the function of DNA polymerase III:
14. To unzip the double stranded DNA chromosome
15. To help uncoil the DNA due to being ‘supercoiled’
16. To extend the new DNA strand by adding new nucleotides onto the growing strand
17. To cut out the RNA primers and replace them with DNA nucleotides
18. To bind together all of the backbones of the Okazaki fragments after all replication has finished
19. This is the name of the small fragments of DNA that are replicated with several RNA primers in between them:
20. Lagging strand
21. Leading strand
22. Okazaki fragments
23. Replication bubble
24. Replication fork
25. This is the name of the specific place where the double stranded DNA is being opened up by enzymes:
26. Lagging strand
27. Leading strand
28. Okazaki fragments
29. Replication bubble
30. Replication fork
31. The central dogma states that:
32. DNA is held in the nucleus, which is translated into an amino acid strand, which leaves the nucleus and is transcribed into a mRNA strand
33. RNA is held in the nucleus which is transcribed into a mDNA strand which leaves the nucleus and is translated into an amino acid strand
34. Amino acid are held in the nucleus, which is translated into a mRNA strand, which leaves the nucleus and is transcribed into a DNA strand
35. RNA is held in the nucleus, which is transcribed into an amino acid strand, which leaves the nucleus and is translated into a DNA strand
36. DNA is held in the nucleus which is transcribed into a mRNA strand, which leaves the nucleus and is translated into an amino acid strand
37. The process by which mRNA is turned into a protein sequence is called:
38. Elongation
39. Initiation
40. Termination
41. Transcribing
42. Translating
43. What is the name of the enzyme that copies the double stranded DNA into a mRNA:
44. DNA polymerase I
45. DNA polymerase II
46. DNA polymerase III
47. RNA polymerase
48. Ligase
49. In the genetic code, how many total codons are there:
50. 1
51. 3
52. 4
53. 16
54. 64
55. What does a codon code for:
56. Amino acid
57. Carbohydrates
58. Cholesterol
59. Lipids
60. Nucleotides
61. After the primary transcript (mRNA) has been formed, what mediates the cutting of introns:
62. 5’ cap
63. Exons
64. Introns
65. Poly – A tail
66. Spliceosomes
67. A ribosome is made up the following parts:
68. A 40S unit
69. A 60S unit
70. A 80S unit
71. A 40S subunit and a 60S subunit that are 80S when together
72. A 40S subunit and a 60S subunit that are 100S when together
73. There are two pockets/active sites inside the ribosome, what are they called:
74. A site and B site
75. B site and C site
76. A site and C site
77. P site and A site
78. P site and B site
79. In which direction is the mRNA read by the ribosome:
80. 3’ to 5’
81. 5’ to 3’
82. 1’ to 3’
83. 3’ to 1’
84. All of the above
85. A tRNA molecule has a part that recognizes a part on the mRNA, what is the name of this part:
86. Anticodon
87. Coding RNA
88. Codon
89. 3’ end
90. 5’ end
91. Which kind of mutation has the least impact on an organism:
92. Deletion
93. Insertion
94. Missense
95. Nonsense
96. Silent
97. Name the enzyme which binds the sticky ends of cleaved DNA:
98. Ligase
99. Restriction endonuclease
100. RNA polymerase
101. DNA polymerase
102. Which jelly like substance is used to form a gel meshwork for electrophoresis:
103. Lysine
104. Amino acid
105. Agarose gel
106. Protein
107. Cellulose
108. Name the extra circular chromosomal DNA found in bacteria:
109. Cosmid
110. Plasmid
111. Nucleus
112. Chromosome
113. None of the above
114. What is the name of the bacteria which is found in hot springs
115. E – coli
116. Nitrosomonas
117. Pseudomonas
118. Thermus aquaticus
119. Bacillus

**Part B:** Application [13]

1. Label any 10 different things in the diagram of replicating DNA. You can make your own arrows. [10]
2. Given a double stranded DNA sequence that is 14 % Guanine. Calculate the percentage of the other 3 bases. [3]

**Part C:** Thinking/Inquiry [13]

1. What if Meselson and Stahl’s observations had looked like the tubes below? What would this mean for their conclusion and why? [3]

|  |  |  |
| --- | --- | --- |
| C:\Users\100411079\Desktop\Biology Senior ABQ\re test scan.pngParents. | C:\Users\100411079\Desktop\Biology Senior ABQ\re test scan.pngFirst Generation | Second Generation  C:\Users\100411079\Desktop\Biology Senior ABQ\re test scan.png |

1. A scientist knows that a bacterium has a biochemical pathway of one reactant, three intermediate substrates and one product, five chemicals all together, which we will call A, B, C, D, and E, which may not occur in this order. The scientist exposes some of the bacteria to radiation to create defective mutants. She finds four nutritional mutants that need one of the five substances added to them in order to get them to grow. The data is shown in the table below. Determine the order of the substrate molecules (A-E) in the biochemical pathway, and the order of the enzymes (E1-E4) that catalyze these reactions. [4]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Enzyme Destroyed | Growth media with A | Growth media with B | Growth media with C | Growth media with D | Growth media with E |
| 1 | - | - | - | + | + |
| 2 | + | - | + | + | + |
| 3 | + | - | - | + | + |
| 4 | - | - | - | + | - |

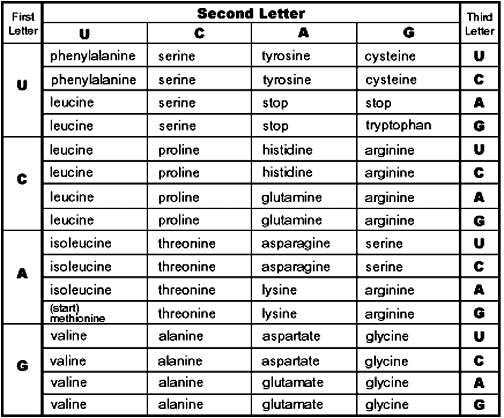
1. Given this DNA sequence: HO – 3’ – TACACACCGGTTCTA – 5’
2. Write out the mRNA sequence for it. [1]
3. Write out the amino acid sequence for that mRNA using the codon chart provided at the end of the test. [2]
4. If there were a mutation in the DNA that changed the 6th nucleotide into a T, what would happen (what is the new protein sequence)? [2]
5. Give one word that would describe what kind of mutation this would be. [1]

**Part D:** Communication [20]

*Choose and perform only* ***two*** *of the following questions:*

1. Describe the chronological steps involved in DNA Cloning. [10]
2. Describe all the steps involved in the process of Transcription (including mRNA processing and post transcriptional modifications). [10]
3. Describe the Lactose operon in the bacteria. [10]

**Codon Chart**



**ANSWER KEY!!!**

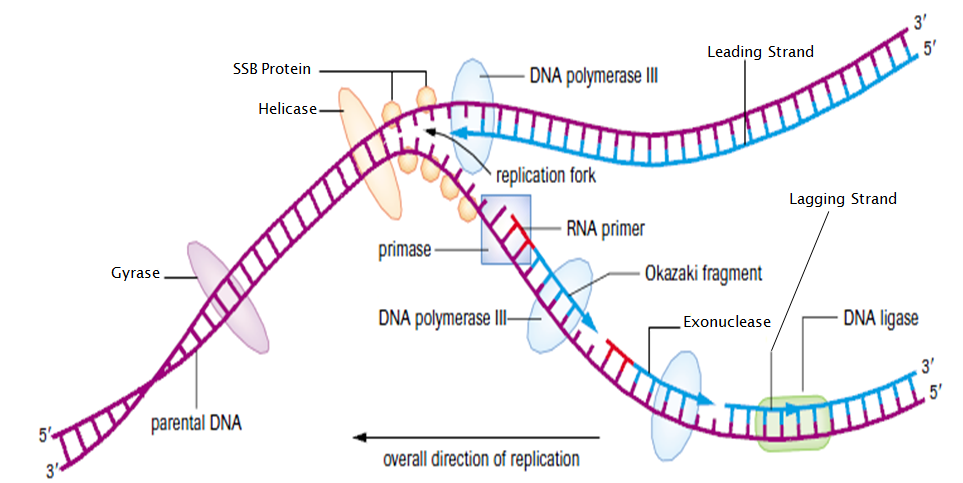
**Part A:** Knowledge/Understanding [20]

*Choose* ***one*** *correct option from each of the following questions.*

1. A Deoxyribonucleoside triphosphate is made up of the following parts:
2. N – base
3. N – base, sugar
4. N – base, sugar and a phosphate
5. N – base, sugar and two phosphates
6. **N – base, sugar and three phosphates**
7. What is the name of the bond that connects the ribose to the N – base:
8. Ester Linkage
9. Glycosidic Bond
10. **Glycosyl Bond**
11. Peptide Bond
12. Phosphodiester Bond
13. What is the function of DNA polymerase III:
14. To unzip the double stranded DNA chromosome
15. To help uncoil the DNA due to being ‘supercoiled’
16. **To extend the new DNA strand by adding new nucleotides onto the growing strand**
17. To cut out the RNA primers and replace them with DNA nucleotides
18. To bind together all of the backbones of the Okazaki fragments after all replication has finished
19. This is the name of the small fragments of DNA that are replicated with several RNA primers in between them:
20. Lagging strand
21. Leading strand
22. **Okazaki fragments**
23. Replication bubble
24. Replication fork
25. This is the name of the specific place where the double stranded DNA is being opened up by enzymes:
26. Lagging strand
27. Leading strand
28. Okazaki fragments
29. Replication bubble
30. **Replication fork**
31. The central dogma states that:
32. DNA is held in the nucleus, which is translated into an amino acid strand, which leaves the nucleus and is transcribed into a mRNA strand
33. RNA is held in the nucleus which is transcribed into a mDNA strand which leaves the nucleus and is translated into an amino acid strand
34. Amino acid are held in the nucleus, which is translated into a mRNA strand, which leaves the nucleus and is transcribed into a DNA strand
35. RNA is held in the nucleus, which is transcribed into an amino acid strand, which leaves the nucleus and is translated into a DNA strand
36. **DNA is held in the nucleus which is transcribed into a mRNA strand, which leaves the nucleus and is translated into an amino acid strand**
37. The process by which mRNA is turned into a protein sequence is called:
38. Elongation
39. Initiation
40. Termination
41. Transcribing
42. **Translating**
43. What is the name of the enzyme that copies the double stranded DNA into a mRNA:
44. DNA polymerase I
45. DNA polymerase II
46. DNA polymerase III
47. **RNA polymerase**
48. Ligase
49. In the genetic code, how many total codons are there:
50. 1
51. 3
52. 4
53. 16
54. **64**
55. What does a codon code for:
56. **Amino acid**
57. Carbohydrates
58. Cholesterol
59. Lipids
60. Nucleotides
61. After the primary transcript (mRNA) has been formed, what mediates the cutting of introns:
62. 5’ cap
63. Exons
64. Introns
65. Poly – A tail
66. **Spliceosomes**
67. A ribosome is made up the following parts:
68. A 40S unit
69. A 60S unit
70. A 80S unit
71. **A 40S subunit and a 60S subunit that are 80S when together**
72. A 40S subunit and a 60S subunit that are 100S when together
73. There are two pockets/active sites inside the ribosome, what are they called:
74. A site and B site
75. B site and C site
76. A site and C site
77. **P site and A site**
78. P site and B site
79. In which direction is the mRNA read by the ribosome:
80. 3’ to 5’
81. **5’ to 3’**
82. 1’ to 3’
83. 3’ to 1’
84. All of the above
85. A tRNA molecule has a part that recognizes a part on the mRNA, what is the name of this part:
86. **Anticodon**
87. Coding RNA
88. Codon
89. 3’ end
90. 5’ end
91. Which kind of mutation has the least impact on an organism:
92. Deletion
93. Insertion
94. Missense
95. Nonsense
96. **Silent**
97. Name the enzyme which binds the sticky ends of cleaved DNA:
98. **Ligase**
99. Restriction endonuclease
100. RNA polymerase
101. DNA polymerase
102. Which jelly like substance is used to form a gel meshwork for electrophoresis:
103. Lysine
104. Amino acid
105. **Agarose gel**
106. Protein
107. Cellulose
108. Name the extra circular chromosomal DNA found in bacteria:
109. Cosmid
110. **Plasmid**
111. Nucleus
112. Chromosome
113. None of the above
114. What is the name of the bacteria which is found in hot springs
115. E – coli
116. Nitrosomonas
117. Pseudomonas
118. **Thermus aquaticus**
119. Bacillus

**Part B:** Application [13]

1. Label any different things in the diagram of replicating DNA. You can make your own arrows. [10]



1. Given a double stranded DNA sequence that is 14 % Guanine. Calculate the percentage of the other 3 bases. [3]

**Given:**

**Required:**

**Analysis**: According to Chargaff rule, in a double stranded DNA sequence,

**Solution:**

Therefore, we have

Let

From the above equation, we can write:

**Paraphrase:** Therefore, the percentages of the following bases are:

**Part C:** Thinking/Inquiry [13]

1. What if Meselson and Stahl’s observations had looked like the tubes below? What would this mean for their conclusion and why? [3]

|  |  |  |
| --- | --- | --- |
| C:\Users\100411079\Desktop\Biology Senior ABQ\re test scan.pngParents. | C:\Users\100411079\Desktop\Biology Senior ABQ\re test scan.pngFirst Generation | Second Generation  C:\Users\100411079\Desktop\Biology Senior ABQ\re test scan.png |

This would mean that the DNA replication is taking place in a conservative way and that’s why they have light 14N bands in the first generation along with the heavy 15 N bands as well. If the DNA is replicating conservatively, one of the original heavy 15 N copy is saved for one of the daughter cells and the other 14 N light copy would be used for another daughter cell in the first generation. Even in the second generation when one of the daughter cells with the heavy 15 N DNA replicates, it produces one heavy 15 N DNA and other light 14N DNA. When the other daughter cell from the first generation replicates, it produces the daughter cells both with light 14N DNA. Hence, in the second generation there are three daughter cells with light 14 N DNA and hence the results above are explained. That is why there is more number of light DNA cells in the second generation.

1. A scientist knows that a bacterium has a biochemical pathway of one reactant, three intermediate substrates and one product, five chemicals all together, which we will call A, B, C, D, and E, which may not occur in this order. The scientist exposes some of the bacteria to radiation to create defective mutants. She finds four nutritional mutants that need one of the five substances added to them in order to get them to grow. The data is shown in the table below. Determine the order of the substrate molecules (A-E) in the biochemical pathway, and the order of the enzymes (E1-E4) that catalyze these reactions. [4]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Enzyme Destroyed | Growth media with A | Growth media with B | Growth media with C | Growth media with D | Growth media with E |
| 1 | - | - | - | + | + |
| 2 | + | - | + | + | + |
| 3 | + | - | - | + | + |
| 4 | - | - | - | + | - |

1. Given this DNA sequence: HO – 3’ – TACACACCGGTTCTA – 5’
2. Write out the mRNA sequence for it. [1]

5’ – AUGUGUGGCCAAGAU – 3’ – OH

1. Write out the amino acid sequence for that mRNA using the codon chart provided. [2]

AUG – Methionine, UGU – Cysteine, GGC – Glycine, CAA – Glutamine, GAU – Aspartic acid

1. If there were a mutation in the DNA that changed the 6th nucleotide into a T, what would happen (what is the new protein sequence)? [2]

5’ – AUGUGAGGCCAAGAU – 3’ – OH

AUG – Methionine, UGA – Stop

1. Give one word that would describe what kind of mutation this would be. [1]

Nonsense mutation

**Part D:** Communication [20]

*Choose and perform only* ***two*** *of the following questions:*

1. Describe the chronological steps involved in DNA Cloning. [10]
2. Generation of DNA fragments using restriction endonucleases

* Appropriate restriction endonucleases need to be used to ensure that the gene fragment in question is excised completely from the source DNA.
* More than one restriction endonuclease may be used at one time.

1. Construction of a recombinant DNA molecule

* The target gene fragment is ligated to a DNA vector (plasmids are one example) and is now recombinant DNA.
* The vector can replicate autonomously in an appropriate host organism.

1. Introduction into a host cell

* Bacterial host cells can be manipulated to take up the recombinant DNA using electroporators, gene guns, or classical transformation protocols, such as calcium chloride.
* Once the bacterium takes up the recombinant DNA, it is referred to as being transformed.

1. Selection

* Cells that have been successfully transformed with the recombinant DNA must be isolated.
* The desired cells are usually chemically selected by the presence of a marker (e.g., antibiotic resistance) on the vector.
* Growth of colonies on media containing the chemical indicates successful transformation of the recombinant DNA vector.
* Individual colonies are isolated from media containing the chemical and are grown in culture to produce multiple copies (clones) of the incorporated recombinant DNA.

1. Describe all the steps involved in the process of Transcription (including mRNA processing and post transcriptional modifications). [10]
2. **Initiation**: The double stranded (double stranded) DNA is present in the nucleus and the enzyme called transcription complex (composed of DNA Helicase and RNA polymerase) comes along. The DNA Helicase unzips the double stranded DNA so that the mRNA can be transcribed against the template strand. There are no single stranded binding proteins and the DNA re-anneals itself into two strands.
3. **Elongation**: once the DNA Helicase unzips the double stranded DNA, the enzyme RNA polymerase comes in and makes a mRNA strand complementary to the template strand which has anti – codon on it with the start codon being AUG. The mRNA is built in the 5’ direction to the 3’ direction.
4. **Termination**: after the mRNA has been transcribed, it falls off the double stranded DNA unzipped molecule along with the transcription complex enzyme which falls off too. The double stranded DNA re – anneal itself and is free of mRNA.
5. **mRNA Processing:** before it leaves the nucleus, the transcribed mRNA also copies the introns from the gene that do not code for any protein. Hence the introns are spliced out of the mRNA using splicosomes. Then a Methyl – G cap is added on to the 5’ end of the mRNA and then a poly – A tail is added to the 3’ end of the mRNA. Then it is known as mRNA proper which leaves the nucleus and goes into the cytoplasm to get translated.
6. Describe the lactose operon in the bacteria. [10]

Lactose is disaccharide that is found in the food products. The Lac operon is a system in which the RNA Polymerase is blocked in its way and it can no longer pass through the operator to transcribe the mRNA from the double stranded DNA because of the binding of a repressor protein Lac I with the operator. Hence when there is no lactose present in the cellular environment, the repressor protein Lac I binds with the operator and blocks the pathway of RNA polymerase and it cannot pass through the gene to transcribe mRNA.

However, on the other hand, if there is enough amount of Lactose present in the cellular environment, the Lactose binds with the Lac I and changes its shape which can no longer bind to the operator and hence the pathway of the RNA polymerase is not blocked and the mRNA is transcribed.